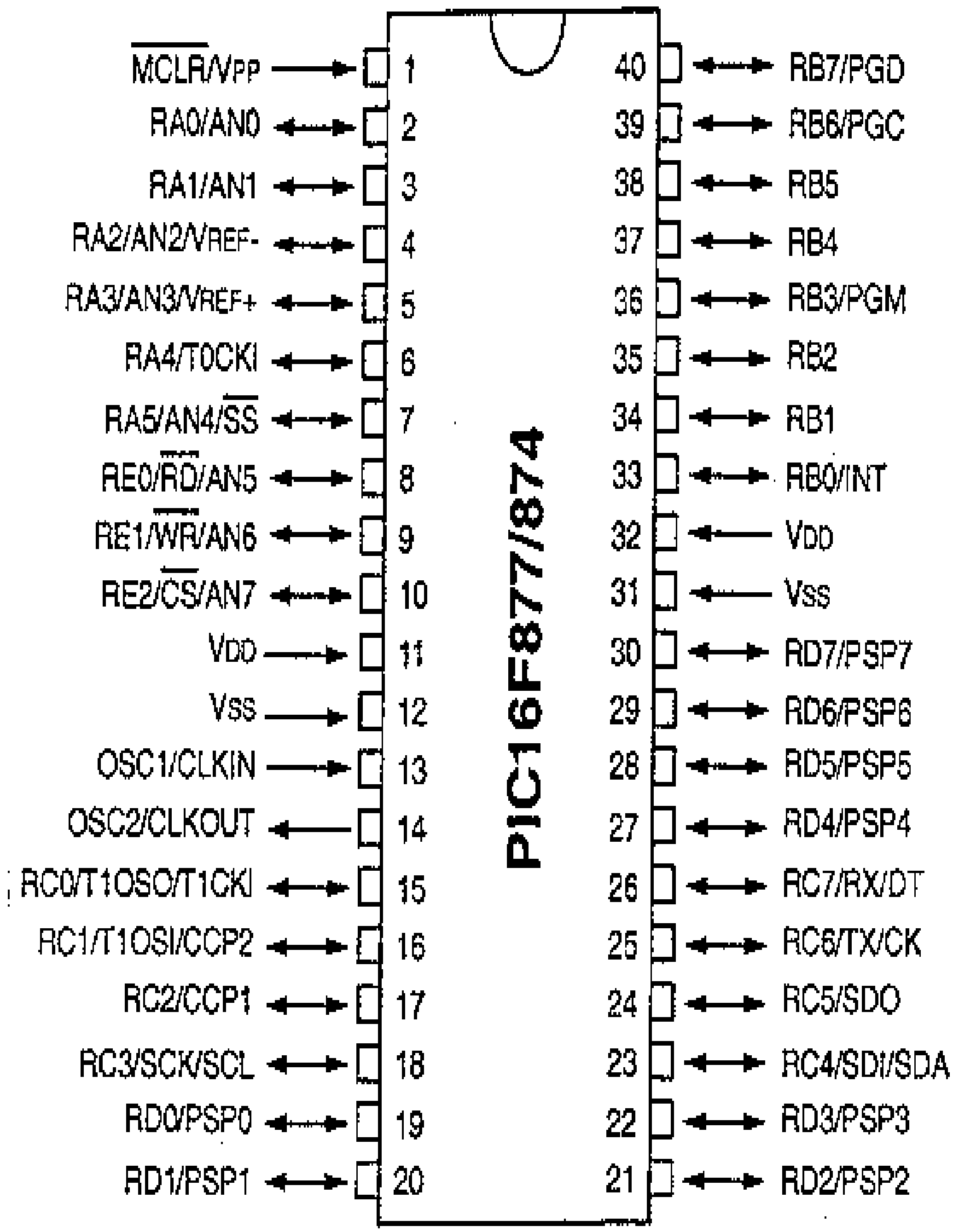
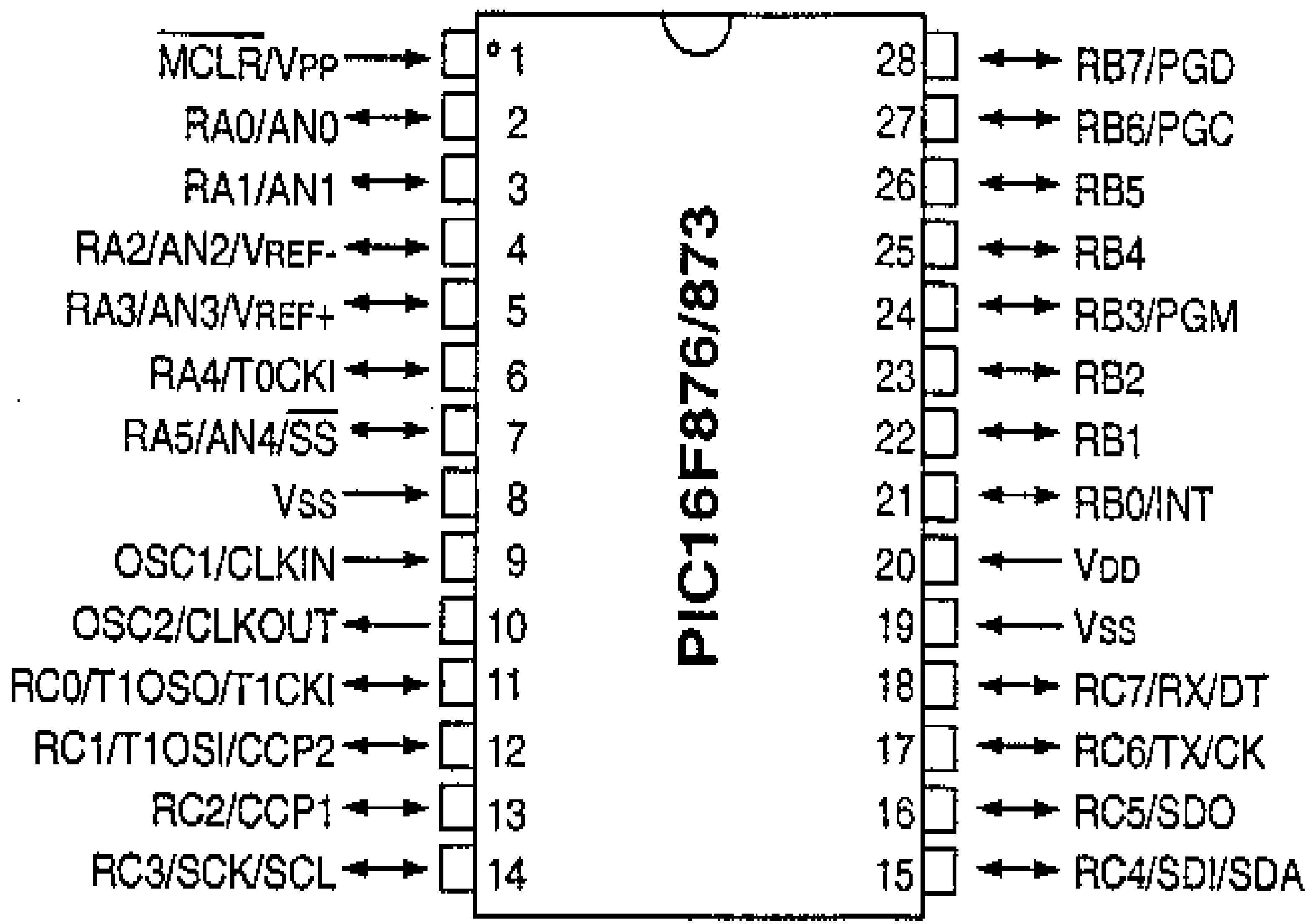
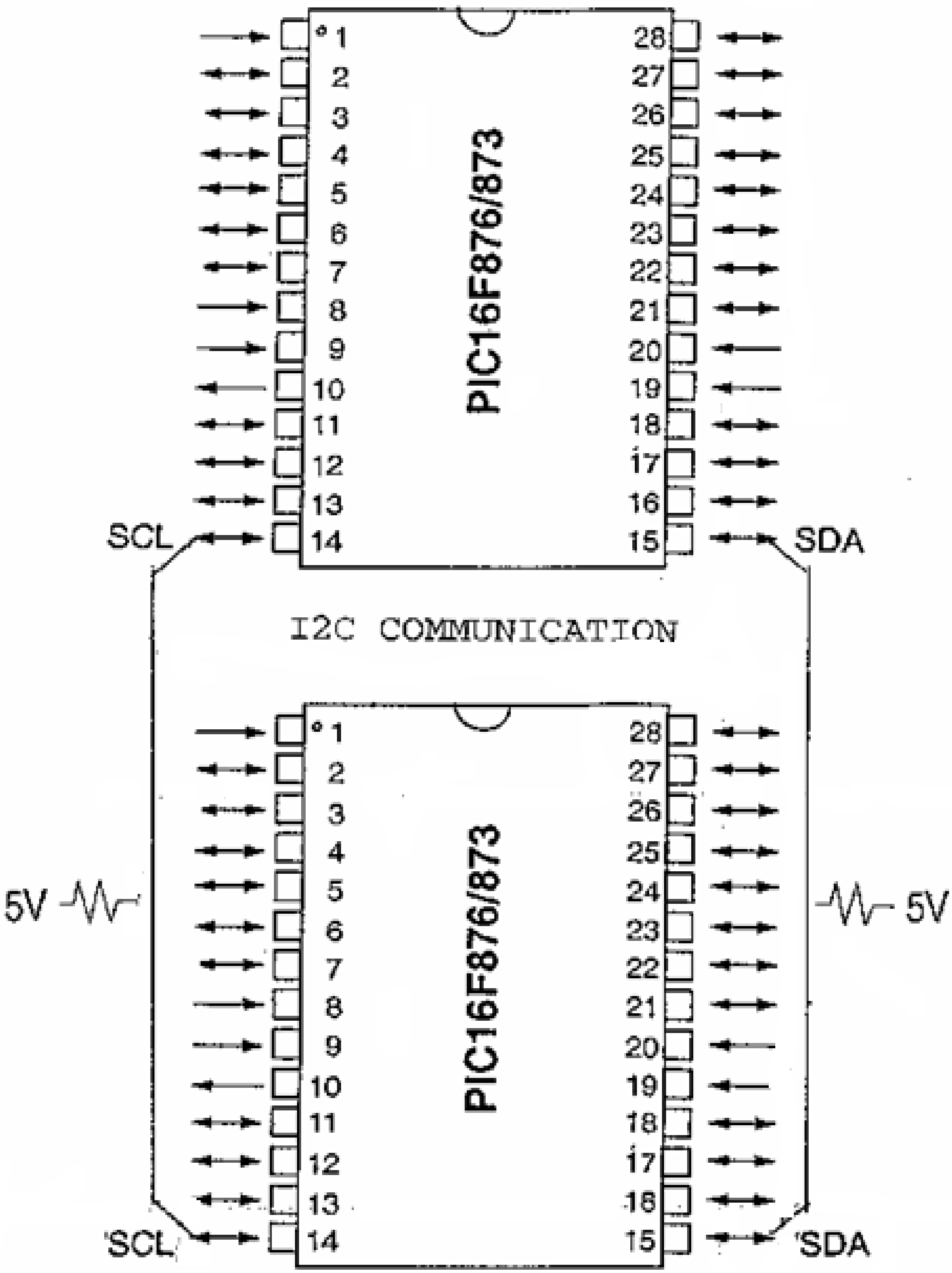
PERIPHERAL INTERFACE CONTROLLERS

There are many different Peripheral Interface Controllers: examples include the PIC16F873 and the PIC16F876 and the PIC16F877. The PIC16F873 and PIC16F876 have the same number of Pins and Ports. The only difference is the 876 has more memory than the 873. The PIC16F877 has more Pins and Ports than the other two PICs. In addition, it has more memory. Schematics of these PICS are given on the next two pages. Port A on each of the PICs can be used for Analog Input. It can also be used for Digital Input or Output. Certain Pins on the other Ports have special uses. All other Pins can be used for Digital Input or Digital Output. Consider the schematic of the PIC16F877. The pins labelled CLKIN and CLKOUT are clock or oscillator pins. The pins labeled CCP1 and CCP2 are PWM pins. The pins labeled SCL and SDA are I2C communication pins. The pins labeled SCK and SDI and SDO are SPI communication pins. The I2C pins allow the PIC to communicate with digital devices such as DACs. The SPI pins can be used to form MASTER/SLAVE PIC networks.

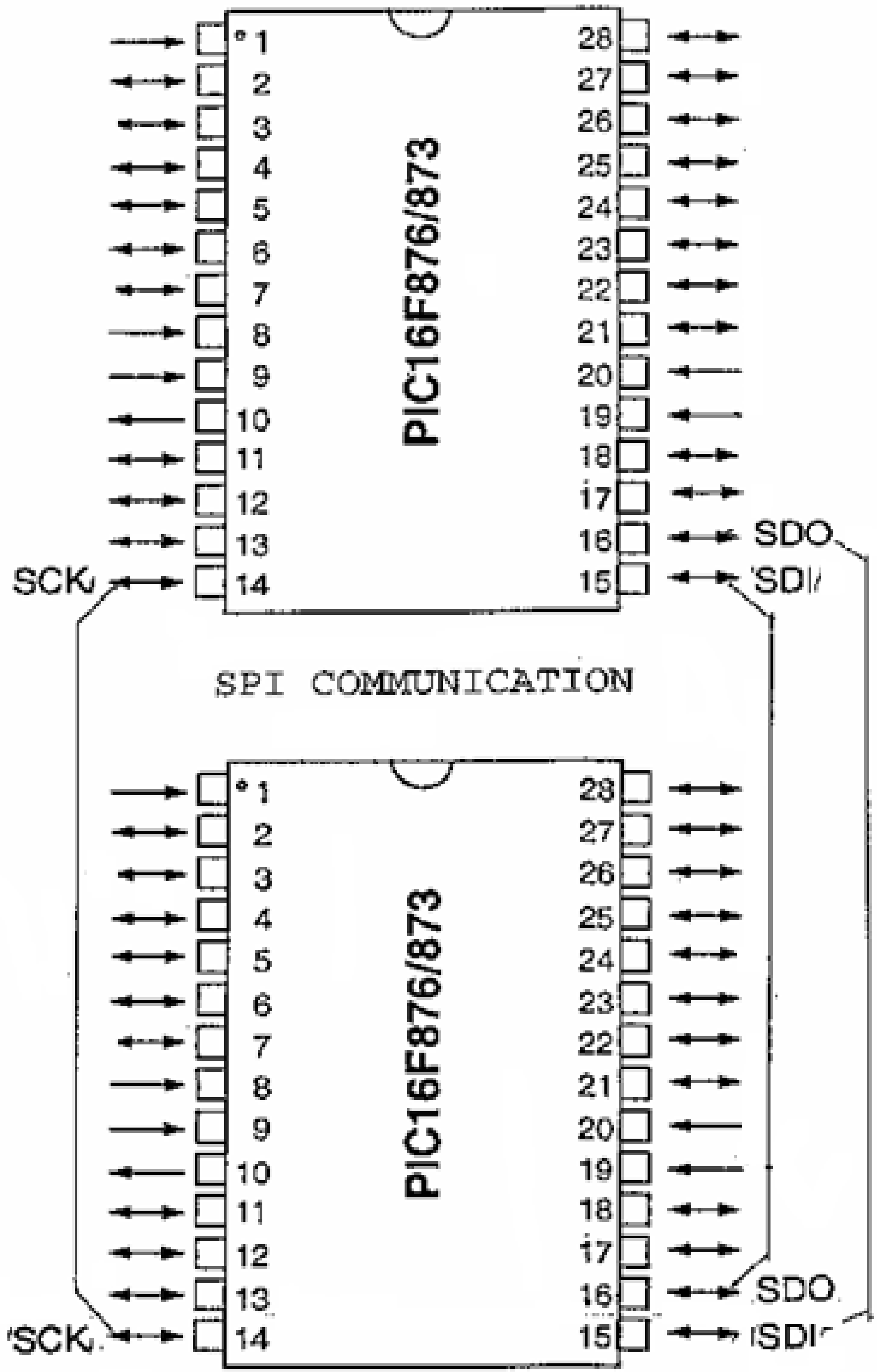


PIC16F877/874
MCLR/VPP
RA0/AN0
RA1/AN1
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/AN4/SS
RE0/RD/AN5
RE1/WR/AN6
RE2/CS/AN7
VDD
VSS
OSC1/CLKIN
OSC2/CLKOUT
RC0/T1OSO/T1CKI
RC1/T1OSI/CCP2
RC2/CCP1
RC3/SCK/SCL
RD0/PSP0
RD1/PSP1
RB7/PGD
RB6/PGC
RB5
RB4
RB3/PGM
RB2
RB1
RB0/INT
VDD
VSS
RD7/PSP7
RD6/PSP6
RD5/PSP5
RD4/PSP4
RC7/RX/DT
RC6/TX/CK
RC5/SDO
RC4/SDI/SDA
RD3/PSP3
RD2/PSP2


PIC16F876/873
MCLR/VPP
RA0/AN0
RA1/AN1
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/AN4/SS
VSS
OSC1/CLKIN
OSC2/CLKOUT
RC0/T1OSO/T1CKI
RC1/T1OSI/CCP2
RC2/CCP1
RC3/SCK/SCL
RB7/PGD
RB6/PGC
RB5
RB4
RB3/PGM
RB2
RB1
RB0/INT
VDD
VSS
RC7/RX/DT
RC6/TX/CK
RC5/SDO
RC4/SDI/SDA



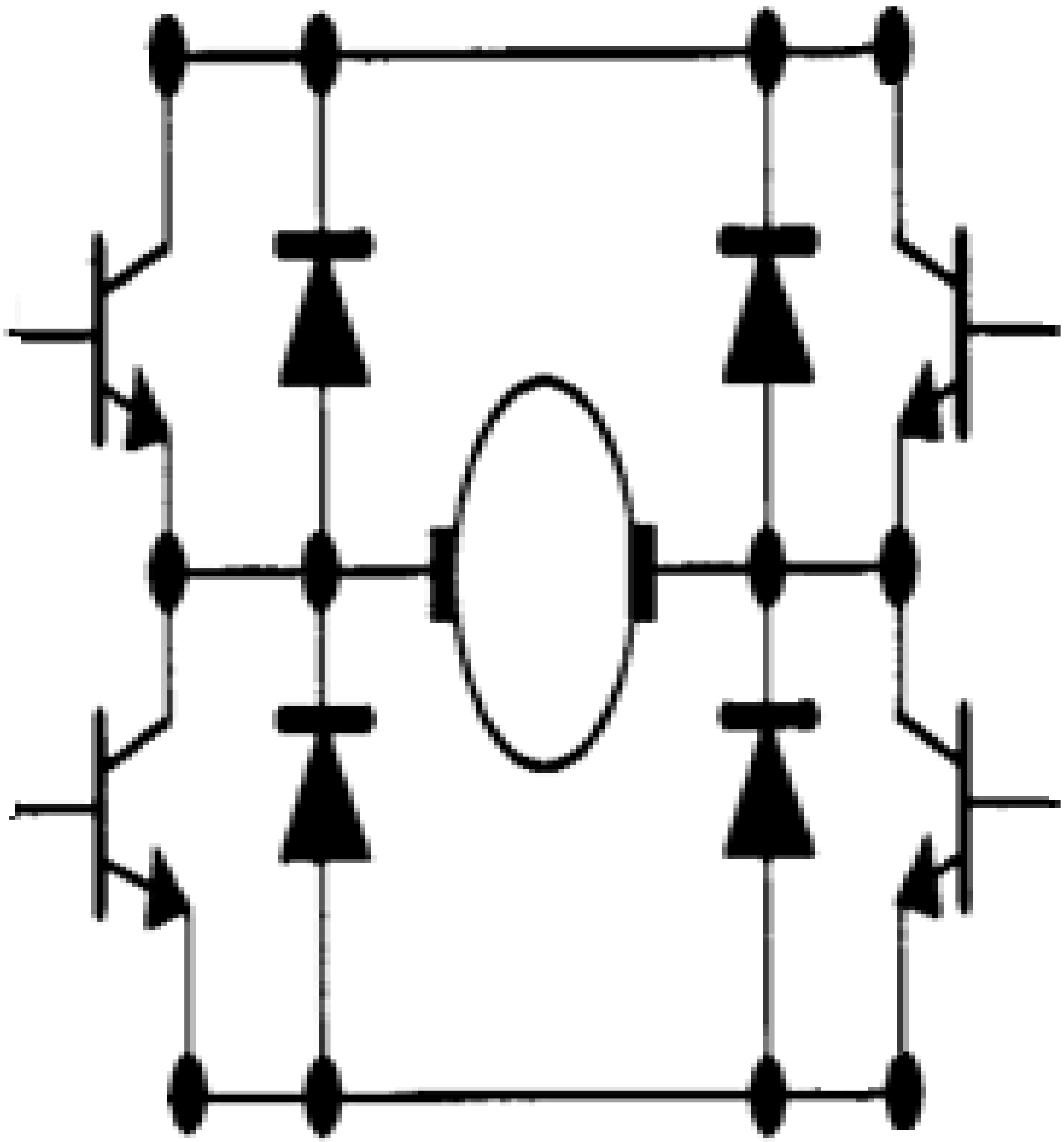
PIC16F876/873
1
2
3
4
5
6
7
8
9
10
11
12
13
14
28
27
26
25
24
23
22
21
20
19
18
17
16
15
SCL
SDA
I2C COMMUNICATION
PIC16F876/873
1
2
3
4
5
6
7
8
9
10
11
12
13
14
28
27
26
25
24
23
22
21
20
19
18
17
16
15
5V
5V
SCL
SDA


PIC16F876/873
SCK
SDO
SDI
SPI COMMUNICATION
PIC16F876/873
SCK
SDO
SDI

H BRIDGE DRIVERS

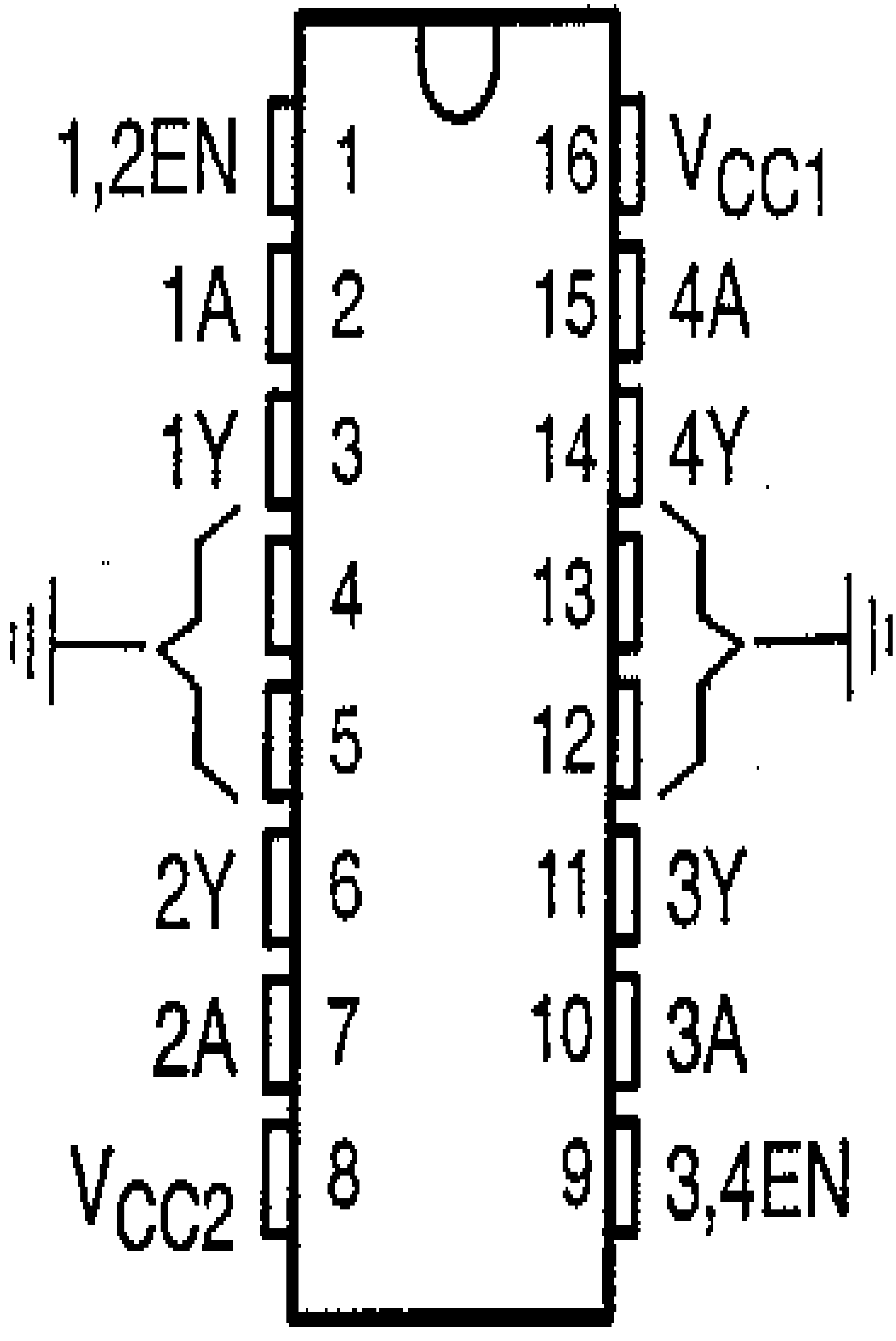
PICs cannot run drives directly because they can generate only a small amount of current. To run devices, they must be connected to drivers. The most common type of driver is known as an H Bridge. It is basically a set of 4 switches arranged in a pattern that looks like the letter H. Schematics of 2 common H Bridges are given on the next two pages. The SN754410 bridge can supply 1 amp while the L298N bridge can supply 4 amps. Bridges can be constructed from MOS FETS for higher amps. Most bridges have what are called ENABLE Pins. These can be used to control the amount of power that a device receives. By sending a PWM signal to these pins, the bridge can be turned ON or OFF. When the bridge is ON, a current loop is completed: when it is OFF, the loop is broken. The power level depends on the PWM duty cycle. Most bridges also have input pins known as DIRECTION Pins. These can be used to make a device such as a DC motor go clockwise or counterclockwise. Another type of driver is known as a RELAY. It can be used to complete or break a current loop, which turns a device ON or OFF.

VOLTAGE

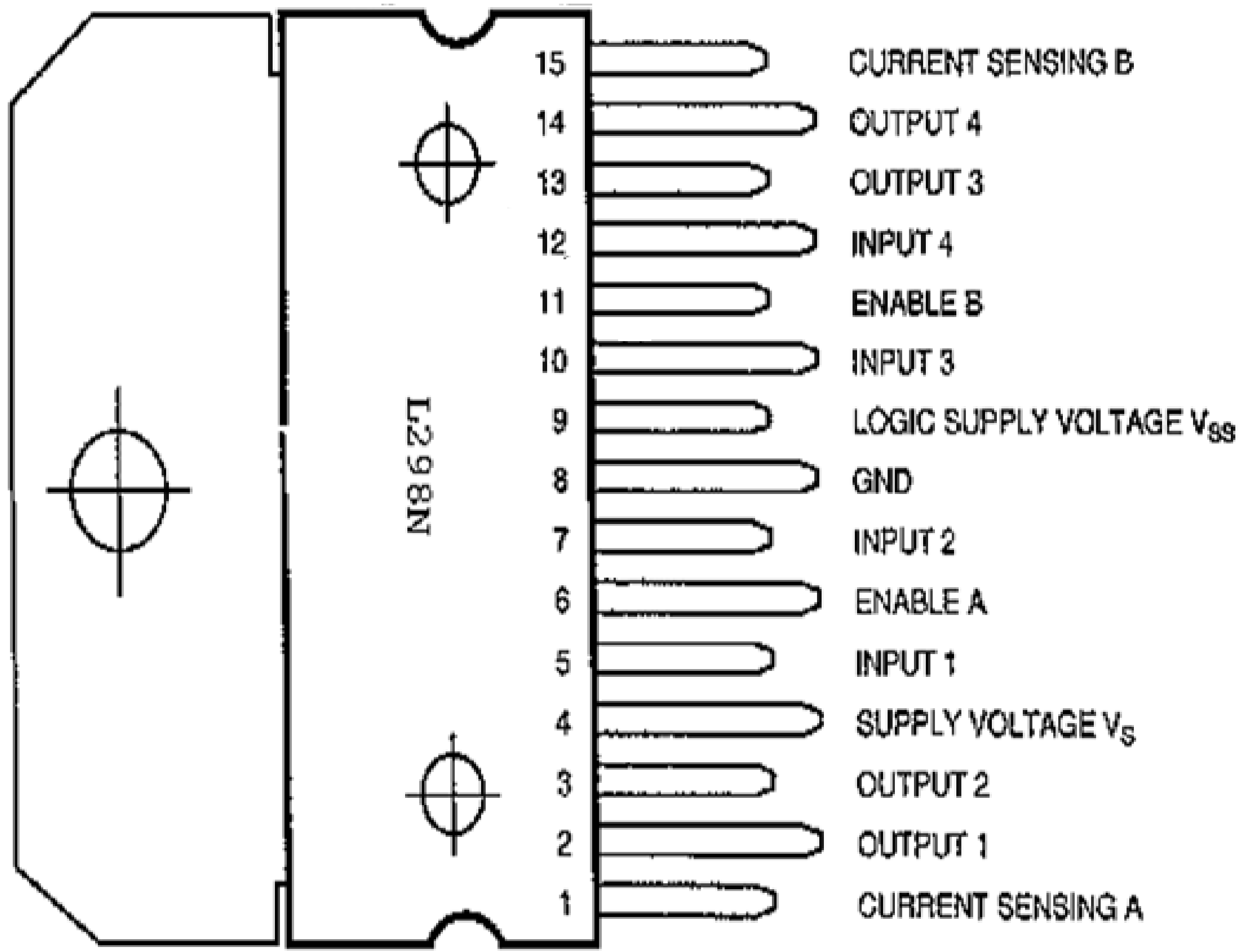


GROUND

H BRIDGE SCHEMATIC


1,2EN
1
1A
2
1Y
3
4
5
2Y
6
2A
7
VCC2
8
16
VCC1
15
4A
14
4Y
13
12
11
3Y
10
3A
9
3,4EN

SN754410

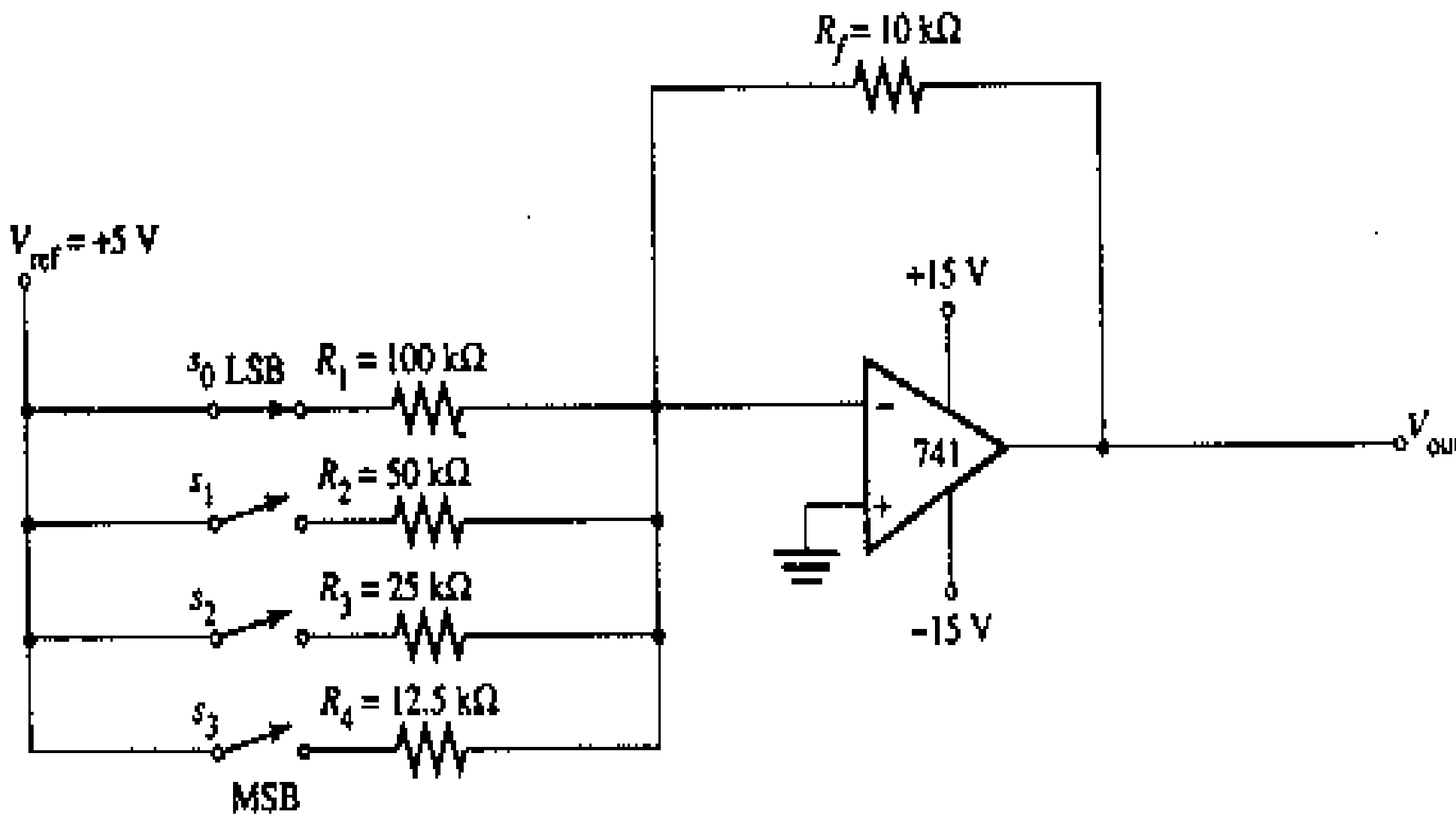

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
L298N
CURRENT SENSING B
OUTPUT 4
OUTPUT 3
INPUT 4
ENABLE B
INPUT 3
LOGIC SUPPLY VOLTAGE V_{SS}
GND
INPUT 2
ENABLE A
INPUT 1
SUPPLY VOLTAGE V_S
OUTPUT 2
OUTPUT 1
CURRENT SENSING A

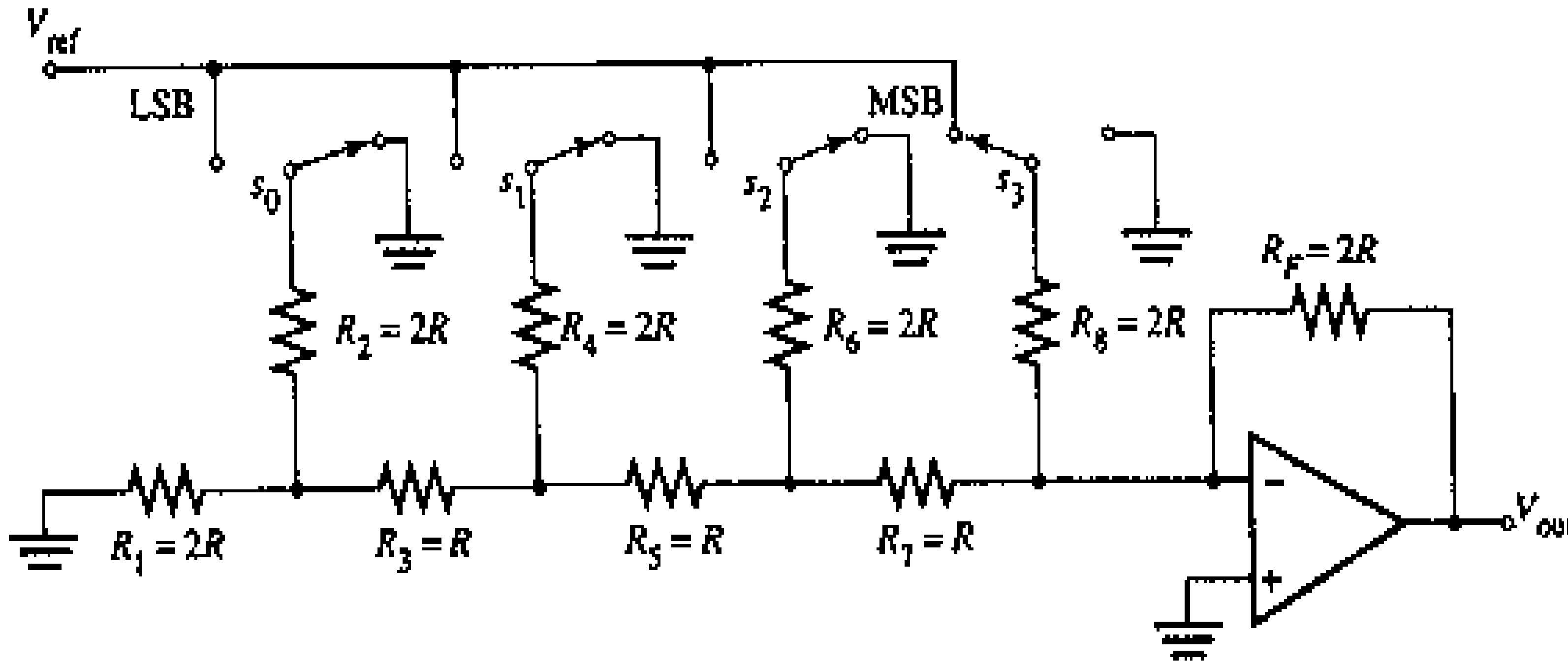
DIGITAL TO ANALOG CONVERTORS

The purpose of a Digital to Analog Convertor or DAC is to take a digital signal generated within a computer control loop and convert it into an analog form so that it can operate some device. There are several different types of DACs. The sketch on the next page shows a BINARY RESISTOR LADDER DAC. The digital signal as a series of ones and zeros controls the switches in the ladder. These in turn control the current which flows through the OP AMP bypass resistor. Circuit analysis shows that the voltage across this resistor is proportional to the digital signal.

Another type of DAC known as an R-2R LADDER DAC is shown on the page after next. It is made up of a number of R and 2R resistor circuits in parallel. Again the digital signal as a series of ones and zeros controls the switches in the 2R leg of the DAC. These in turn control the current which flows through the OP AMP bypass resistor. Circuit analysis shows that this is proportional to the digital signal.

BINARY RESISTOR LADDER DAC



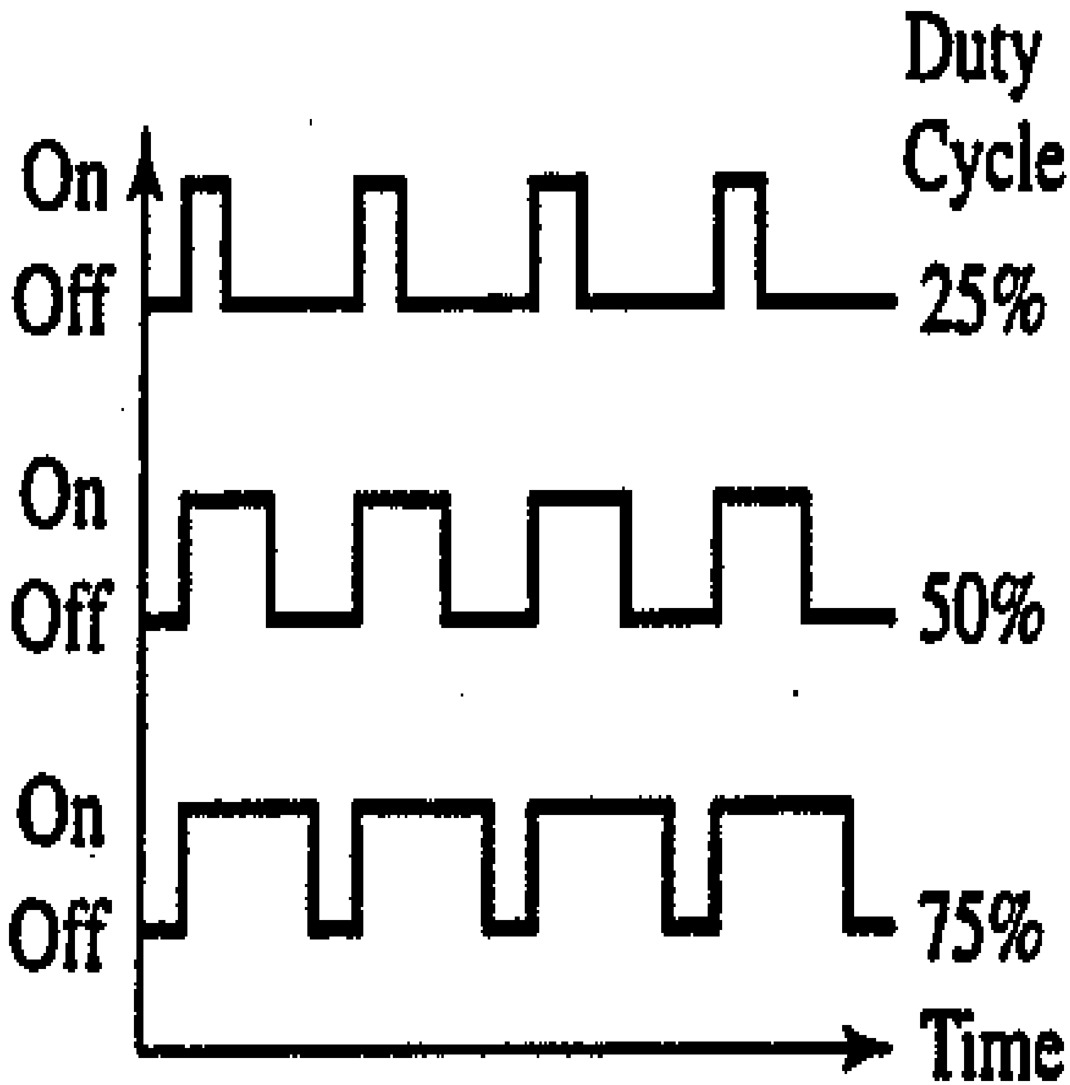


R-2R RESISTOR
LADDER DAC

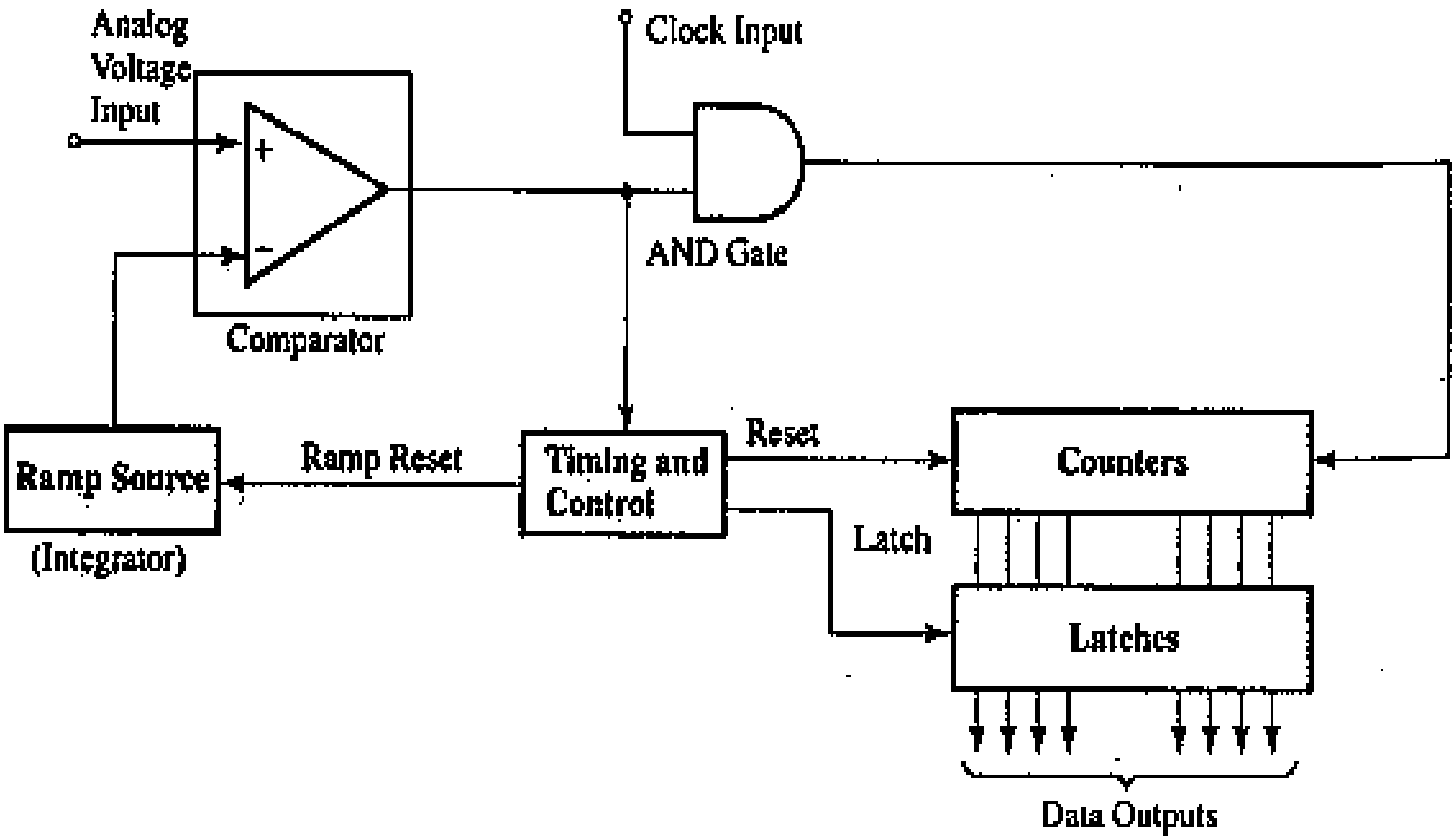
Another type of DAC makes use of something called Pulse Width Modulation or PWM. The duty cycle of the PWM signal is a measure of the digital signal. An illustration of a PWM signal is given on the next page.

ANALOG TO DIGITAL CONVERTORS

The purpose of an Analog to Digital Convertor or ADC is to convert an analog signal from a sensor into a digital form within a computer control loop so it can be used for control. There are several different types of ADCs. The sketch on the page after next shows a RAMP ADC. The analog signal to be sampled is compared with a signal which ramps upward in time. When the ramp signal becomes greater than the analog signal, a counter is stopped. The number of counts is a measure of the analog voltage level. Another ADC uses a DAC to create a comparison voltage.



PULSE WIDTH
MODULATION


Analog
Voltage
Input
+
-
Comparator
Clock Input
AND Gate
Ramp Source
(Integrator)
Ramp Reset
Timing and
Control
Reset
Latch
Counters
Latches
Data Outputs

RAMP ADC

DATA REPRESENTATION

The decimal system uses the number 10 as a base and numbers from 0 to 9 to represent data. One can write for integers:

$$+ \square\ 10^{+3} + \square\ 10^{+2} + \square\ 10^{+1} + \square\ 10^{+0}$$

In this system one can write the number 99 as

$$9\ 10^{+1} + 9\ 10^{+0} = 90 + 9 = 99$$

The binary system uses the number 2 as a base and numbers 0 and 1 to represent data. One can write for integers:

$$\square\ 2^{+7} + \square\ 2^{+6} + \square\ 2^{+5} + \square\ 2^{+4} + \square\ 2^{+3} + \square\ 2^{+2} + \square\ 2^{+1} + \square\ 2^{+0}$$

In this system one can write the number 99 as

$$0\ 2^{+7} + 1\ 2^{+6} + 1\ 2^{+5} + 0\ 2^{+4} + 0\ 2^{+3} + 0\ 2^{+2} + 1\ 2^{+1} + 1\ 2^{+0}$$
$$= 0 + 64 + 32 + 0 + 0 + 0 + 2 + 1 = 99 = 01100011$$

The maximum number one can get is

$$111111111 = 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = 255$$

There are 8 bits to this number: so it is generally referred to as 8 bit. If we add □ 2^{+9} and □ 2^{+8} we get 10 bit. The maximum number in this case is 1023. Computers use the binary system to perform calculations.

Because of its low base the binary system is not the most compact way to represent data. A more compact way is the hexadecimal system. This system uses the numbers 0 to 9 and the letters A to F. The letters A to F represent the numbers 10 to 15. The base of the hexadecimal system is 16. The binary number for 16 is 1111. One can break binary numbers up into bytes each 4 bits long. For example consider the binary number:

0100 1010 1100

The hexadecimal equivalent is 4AC. The decimal number is 684. For a number with a decimal point one considers the numbers either side of the decimal point separately. For example the hexadecimal equivalent of the binary number

[0100 1010 . 1100]

is [4 A . C]. The decimal number is [74.12].